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AIRPORT TRAFFIC AND THE PUERTO RICO INTERNATIONAL AIRPORT

by Walther Prokosch

AIR TRANSPORT DIVISION

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AIRPORT TRAFFIC AND THE PUERTO RICO INTERNATIONAL AIRPORT

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When I was asked to prepare a paper on the subject of airport traffic, I began to speculate as to which phase of traffic would be of greatest interest to an audience composed of engineers and designers. Would it be the air traffic in the immediate vicinity of the airport? Would it be the ground traffic of airplanes on the airfield? Or would the forecasting of different types of traffic at the airport - i.e., passenger and cargo - be of greater interest? Then again, I considered the traffic of the passenger moving within the airport terminal and the traffic of the cargo moving through the cargo terminal. Also to be considered was the vehicular traffic which would serve the airport and play its important role in making the entire enterprise function.

Actually, in the design of an airport or airport terminal all of these forms of traffic are important, are inter-related, and must be considered. Therefore, it seemed that the most meaningful paper might be the actual case history of the evaluation of the design of the Puerto Rico International Airport, including a short review of the traffic forecasts which were made and an exposition of the relationship of these forecasts to the actual design of the installation. Much excellent material has been published on the subject of air traffic forecasting and every airport planner has his own thoughts as to the best way of preparing these forecasts. At best they can only be broad approximations. The significant phase of any airport consultants work is the interpretation of statistics to determine the best organization of buildings, traffic and other facilities for a given airport.

TRAFFIC FORECASTS

In August of 1950 the Puerto Rico Transportation Authority asked our firm to prepare a Survey of Design Requirements for the Puerto Rico International Airport. In making this request, the Authority showed an understanding of the interdependence of traffic forecasting and building requirements since the survey was to produce as its end result a schedule of airplane parking and building space requirements. The design of facilities was entrusted to our firm together with the Puerto Rican architectural firm of Toro, Ferrer & Torregrosa as associates.

Every community or area has its own local characteristics which must be explored and evaluated in the preparation of a traffic forecast - be it for vehicular, air or any other kind of traffic. Puerto Rico's geographic location and its topographic limitations had a strong influence on the evaluation of future traffic. An island supporting almost three million people, situated 1000 miles from the mainland to which it is tied politically and economically, will obviously be a good candidate for air traffic. An island which already is exploiting every square foot of land for agriculture must turn to indus-

trialization to support its expanding population, which again bolsters the case for increased air transportation.

The pattern of economic development which has occurred and which appears to be continuing was investigated, with population being the first item of intensive study. This was followed by a study of the history of employment in Puerto Rico, followed by studies of automobile use, imports and exports, agriculture, the use of radio and telephone, per capita income, and various business indices including migrant labor, agricultural employment, electric power production, cement production, and building permit value. The plotting of graphs for all of these factors indicated a generally rising curve, bearing out the contention that Puerto Rico is due for considerable economic growth along with its anticipated population growth. (Fig. 1)

The pattern of migration was next studied and it was found that the net migration loss has been increasing steadily since 1928. In spite of the improvement of economic conditions in Puerto Rico, we have estimated that the net migration loss will continue to increase gradually. Temporary migration, which includes agricultural workers who go to the United States to work under contract for the harvesting season, was also studied. Although this activity had been under way for only three years prior to the preparation of the report, enough evidence was obtained to indicate that the temporary agricultural worker would continue to migrate to the mainland by air in ever increasing numbers.

Another characteristic of Puerto Rico, which has a considerable bearing on anticipated air traffic, is the close tie between the homeland of Puerto Rico and the Puerto Rican colony in the United States - particularly in New York. A very sizable traffic may be attributed to the presence of this colony, which induces members of a family to visit each other during the course of a year and which will expand as the colony itself expands.

Then, tourist business was considered. It is obvious to even the most casual observer that the efforts of the Puerto Rican Government to induce additional tourist trade are bearing successful fruit, which again means increased air traffic. Airlines also have been conducting an intensive advertising campaign, extolling to tourists from the mainland the many attractions of Puerto Rico.

Additional factors which were studied in this traffic survey were the students, businessmen, and others traveling back and forth between Puerto Rico and the continental United States and other countries having close ties, such as Spain; traffic to and from the Virgin Islands and other Caribbean islands, most of which funnels through Puerto Rico. Also, there exists considerable intra-island traffic in Puerto Rico which is expected to increase as airport facilities in other parts of the island are improved.

Finally, the in-transit passenger traffic at San Juan was investigated and the conclusion was reached that this was the only traffic which would not increase. It is believed that the future pattern of traffic between the United States and South America will call for a greater number of long-range through flights which will not stop at San Juan.

The anticipated traffic in each of the categories previously mentioned was forecast separately and then totaled. As a matter of record, the traffic estimate which we prepared two years ago shows an increase from some 300,000 passengers in 1950 to 508,000 passengers for 1955, rising to 968,000 in 1970. Actually, during the year 1952 it is anticipated that there will be over 400,000 passengers and, therefore, unless there is a sharp decline in the curve, our estimates will be on the low side - as have been almost all of the air traffic

forecasts that have ever been made! (Fig. 2) It may be well to point out in self-defense that estimates of future traffic must necessarily be conservative to justify sound financial procedures.

Air mail traffic forecasts were then made, based in general on the economic data examined for passenger traffic. Finally, the potential of air cargo was investigated. It was found that Puerto Rico may look forward to a considerable volume of air cargo which will be accounted for because of the continuing necessity for importing various types of foodstuffs and manufactured goods. The increased industrialization of the island will also contribute to the increase of this category of traffic. The total air cargo traffic estimated for San Juan in 1970 is slightly less than one million tons. (Fig. 3)

REQUIREMENTS FOR AIRPLANE PARKING POSITIONS

How does the designer put all of this information to practical use? First of all he wants to know how many airplane parking positions will be required at the terminal, since this is the basis for planning a terminal. This figure, together with the anticipated annual passenger volume, will enable him to begin developing the basic design of the terminal building. The same process applies to the cargo terminal.

In addition to these fundamental requirements, the designer should try to sift from his forecasts certain significant characteristics:

1. The proportion of long-haul to local traffic. The importance of this factor lies in the fact that it gives a clue to airplane types, and also has an effect on the utilization of airplane parking positions at the terminal apron.

2. The proportion of terminating to through or in-transit flights. This affects airplane parking position utilization both in terms of time as well as pattern and may have a profound influence on the design of the terminal building. A terminating flight will spend less time at the apron than one which is passing through and requires extensive servicing while on the ground. The pattern of an airport terminal building operation will be very different if most of the flights are through flights from that of a terminal having principally terminating and originating flights, as will be demonstrated later. Finally, this characteristic will also affect requirements for short-term aircraft parking away from the terminal building.

For San Juan we found that the proportion of long-haul to local traffic was very high and also that most of the flights were terminating or originating rather than in-transit flights.

Once the traffic estimate had been completed, our attention was focused on estimating the number of airplane parking positions which would be required both for the passenger and cargo terminals. In order to arrive at the required number of airplane parking positions, the following steps were taken:

1. The peak hour traffic was estimated. This was done in two different ways: first, by using the factor of .0043 per cent of annual traffic which was developed by the Civil Aeronautics Administration as a result of a survey made by that agency at San Juan in 1950; and secondly, by relating peak hourly traffic to peak daily and peak monthly traffic. The former method was used for design purposes since it appears to be the scientifically more accurate one. However, it resulted in a peak hourly traffic forecast for 1955 of only 215 passengers which, in our opinion, is too low. Actually, the traffic at San Juan has already reached this peak on several occasions.

2. The estimated average airplane seating capacity for a given future year was forecast, first, by predicting the plane types which would be in service in that year, with their seating capacities; second, by estimating the relative frequency of operation of such planes; and third, by applying to the product of the former two groups of figures an estimated load factor.

3. The airplane parking position utilization at the terminal (or time during which an airplane will occupy its parking position) was estimated, and for this the relative frequency of terminating or originating aircraft versus in-transit flights was an all-important factor.

4. The peak hour traffic was divided by the average seating capacity, which resulted in the number of operations per hour.

5. The number of operations per hour was divided by the airplane parking position utilization factor. This then gave the number of airplane parking positions required. Our estimate for 1960 was 10 airplane parking positions and 14 positions for 1970. (Fig. 4)

A somewhat similar process was carried out for the cargo airplane parking positions, substituting potential payload for seating capacity, and the number of positions required for that type of service was determined. This resulted in an estimate of four positions for 1960 and nine for 1970.

The last chapter in the survey consisted of tabulating all of the space presently utilized in the passenger and cargo terminals as well as the personnel inhabiting these spaces. Then by applying the knowledge gained from the traffic forecasts, a comparative table was set up showing square foot building requirements and personnel estimates for 1960 and 1970. (Fig. 5)

APPLICATION OF FORECASTS TO DESIGN

Having completed what might be termed the statistical phase of the design, the next activity was the study of aircraft traffic on the ground. Fig. 6 illustrates the relative simplicity of runway traffic which may be obtained in San Juan due to the monodirectional characteristics of the Trade Winds. The Puerto Rico Transportation Authority had previously plotted the landing-roll requirements of anticipated aircraft, and determined optimum exit points from the runway ends. High-speed diagonal taxiways were installed at those points. A one-way system of traffic was evolved which would result in the shortest taxi distances for both arriving and departing aircraft. In addition, the problem of relating cargo to passenger operations was studied. It was determined that these two types of traffic should be adjacent to but not directly touching each other so that either one might expand as required. Thus, the taxi pattern was also studied to permit a smooth flow of traffic to and from the cargo terminal.

The setting of a logical taxiway traffic pattern permitted the next step to be taken - the disposition of airplane parking positions about the terminal area. As Fig. 7 shows, terminating traffic is brought to a given point where the passengers may be discharged. From that point the aircraft may be towed to its short-term parking space if it is departing within a relatively short time or to the nearby hangars for maintenance. In-transit flights or short turn-around flights are docked about the corner where they are equally accessible to the various parts of the building which bear a relationship to such traffic. This location also permits the aircraft to remain in the continuous one-way traffic pattern which was evolved. Outbound airplane parking positions

are placed in a row, facing the runway and closest to its take-off end, so that departing aircraft will have the shortest taxi distance. It must be stated here that this pattern of airplane parking positions was achieved only because of the enlightened attitude of the air carriers serving Puerto Rico to agree to the sharing of such positions.

Having determined the best taxi pattern for aircraft and the optimum theoretical location for airplane parking positions, it became possible to initiate studies dealing with the shape of the terminal building itself. The location of the airplane parking positions on a corner, which would produce the proper relationship of terminating to in-transit to departing aircraft, immediately suggested certain locations for the principal features of the building. Going back for a moment to the earlier assertion of the importance of determining the relationship of terminating to in-transit flights, we were able to simplify greatly the basic pattern of the building because of the high percentage of terminating and originating flights. It has been proven by various studies that the interests of the departing passenger are rather different from those of the arriving one. The departing or in-transit passenger will spend time and money wandering around the building and patronizing its concessions, whereas the terminating passenger is principally interested in getting to his home or to his hotel room. This is a general characteristic of human nature and applies to all forms of transportation. Therefore, it would seem desirable to permit the termination passenger to get to his baggage and his means of transportation as quickly as possible, and to place concessions within proximity of the departing or in-transit passenger. In addition to giving the proper emphasis to concessions, such a differentiation also permits the simplification of internal circulation by diverting passengers to separate entrance and exit points. At San Juan the problem was made more complex because of the fact that all of the passengers (with the exception of a small amount of intra-island traffic) are subjected to some type of Government inspection. If these Government inspection rooms could be placed in one block and all such traffic closely related to that block, then the building itself would become simpler. Similarly, it is obvious that with a high percentage of terminating or originating traffic, the proper location for airline ticket counters is related to the outbound passenger rather than the inbound passenger. So it was determined to have an outbound concourse which would be the principal room in the building and to place within that room all of the ticket counters and most of the concessions. This room was then related to the outbound airplane parking positions, while the block or Government offices was related to the inbound airplane parking positions. (Fig. 8)

Airlines like to have their operational offices closely related to their ticket counters. Also, baggage handling is fairly easy if gravity can be used for flow from one level to another. Therefore, the airline operations offices were placed directly below the outbound concourse and the ticket counters connected thereto by means of horizontal conveyor belts, chutes to the lower level, and staircases for personnel. This raised the outbound concourse to a second-floor level which was desirable not only to segregate the passengers from other traffic but also to permit the future installation of mechanical airplane loading devices.

As with passengers, the processing of an aircraft for a terminating or originating flight is different from that for a through flight. This has a definite effect on apron services and service pit requirements. A segregation according to type may result in considerable reduction of services, such as

air conditioning, and therefore, in construction cost savings.

Fig. 9 shows the building plan as it was finally evolved. An additional element was added in the center which serves as a general distribution point for all passengers and is placed at a half level between the second floor outbound concourse and the ground floor inbound Government process area. This latter, incidentally, was kept at ground level in order to facilitate baggage handling and do away with lifting baggage mechanically to an upper floor.

Finally, the vehicular traffic to the terminal was broken down in such a manner that only the traffic directly related to departing passengers and taxis for incoming passengers would utilize the main entrance ramp. (Fig. 10) Service traffic is diverted before it gets to the ramp as is the traffic for the parking lots. The major lot is connected with the terminal through a short pedestrian underpass. Limousine traffic for arriving passengers is located in such a manner as to be accessible but not to add to the traffic of the main entrance road. All of this has as its basis the thought that the most critical vehicular time is the last few minutes before plane departure, and anything which can be done to make it easier for the passenger to catch his plane at the last minute will probably be appreciated.

Fig. 11 showing ground traffic also illustrates the manner in which traffic to the cargo and hangar areas is handled. For the cargo terminal an analysis similar to that for the passenger terminal was made. Since inanimate objects are much easier to handle than people, the design of a cargo terminal is a much easier problem and it was possible to evolve a simple building and a simple ground traffic pattern.

To summarize, it appears that if the Puerto Rico International Airport passenger terminal makes a contribution to the planning of such structures, it will lie in the fact that it is the first concrete demonstration of the practicability and advantages of segregating inbound from outbound traffic.* This will give rise to (a) simplified airplane traffic circulation on the ground; (b) simplified passenger circulation within the building; (c) less expensive pit installations in the apron since air conditioning pits and other services can be eliminated from terminating positions; and (d) a more functional relationship of concessions to potential buyers.

This paper would not be complete without a short description of a special category of traffic which is met in large volume only in Puerto Rico and the manner in which it was accommodated; namely, that of relatives and friends accompanying a departing traveler. We have heard of instances in which as many as 30 carloads of people have gone to the airport to speed a single passenger on his way! All of the friends like to be with the passenger until the last moment; And when he has started out to his airplane, they all rush to the observation deck in a body. The plan of the building shows how staircases for this purpose have been strategically spotted in the building and also indicates an out-size observation deck both for outbound as well as for inbound airplanes.

When we began our assignment, we were told that no other airport has the diverse problems which exist at Puerto Rico. Now that we are nearing completion of the work, we are convinced of this fact; but all of them have been interesting and rewarding problems! The complete cooperation which we have had from the Puerto Rico Transportation Authority, the Civil Aeronautics Administration and the air carriers has made this assignment a pleasant experience as well.

*(Cf. Airport Terminal Design - A Selective Method of Planning by Walther Prokosch, December 1947)

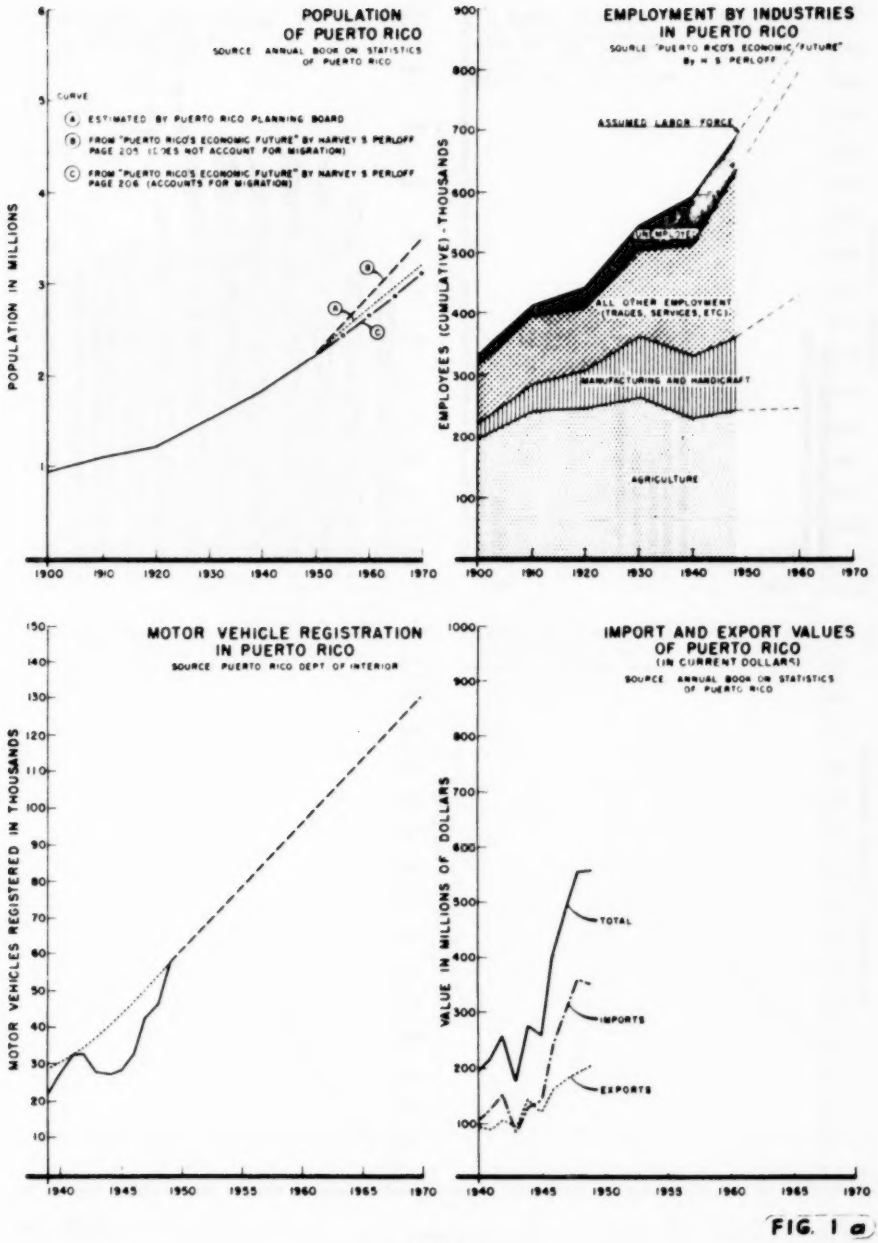

FIG. 1 a

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NEW YORK, N. Y. OCTOBER 15, 1950

SURVEY OF DESIGN REQUIREMENTS

PUERTO RICO INTERNATIONAL AIRPORT
PUERTO RICO TRANSPORTATION AUTHORITY

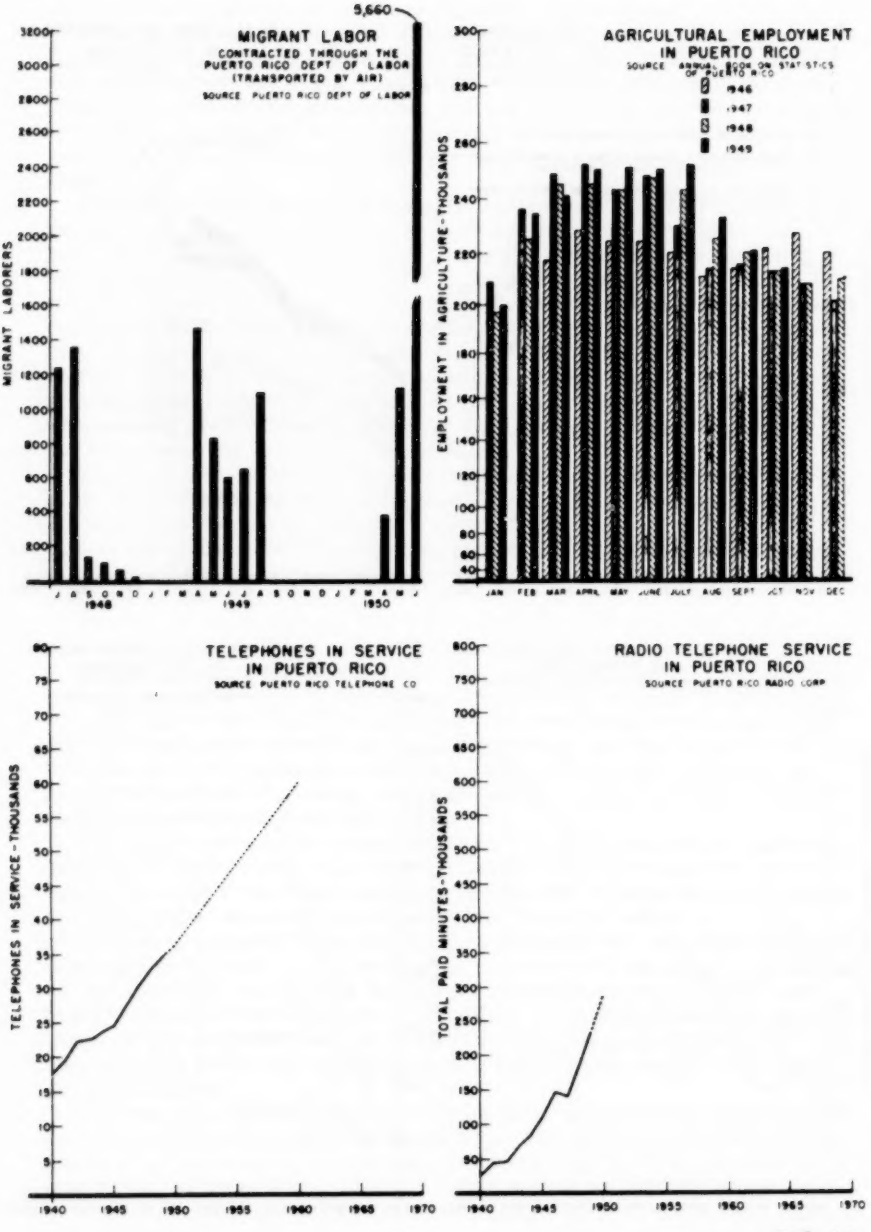

FIG. 1b

SURVEY OF DESIGN REQUIREMENTS

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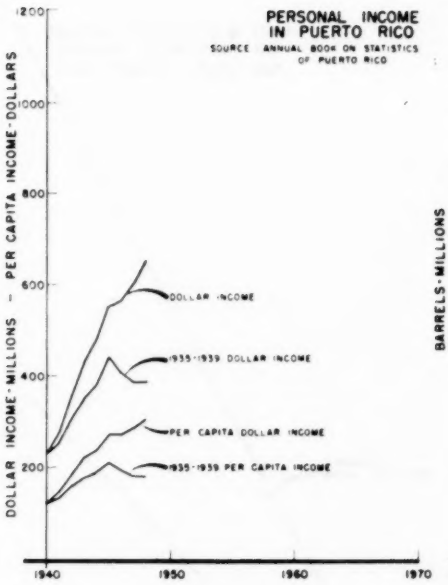

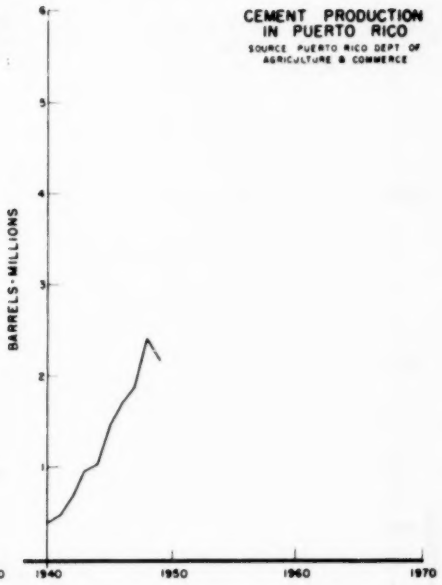

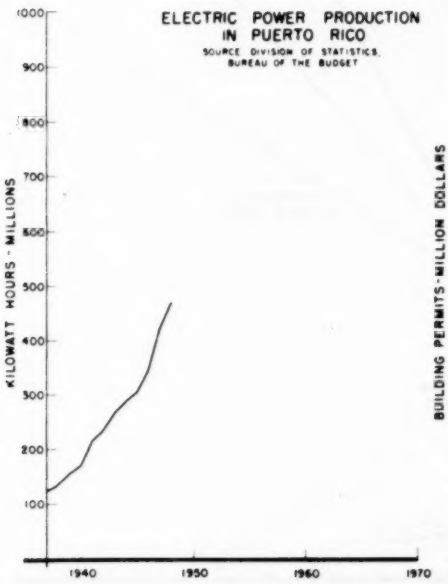

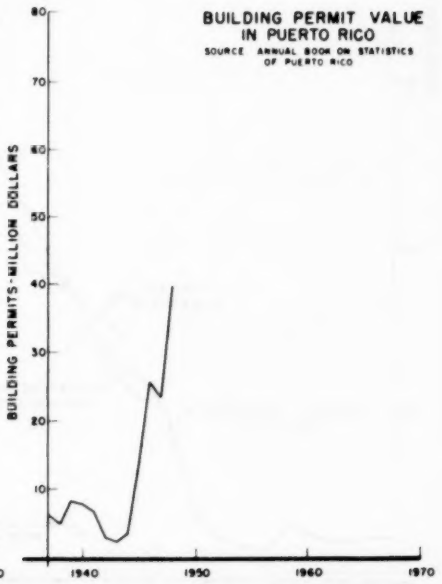

FIG. 1 c

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OCTOBER 15, 1950

SURVEY
OF
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PUERTO RICO TRANSPORTATION AUTHORITY

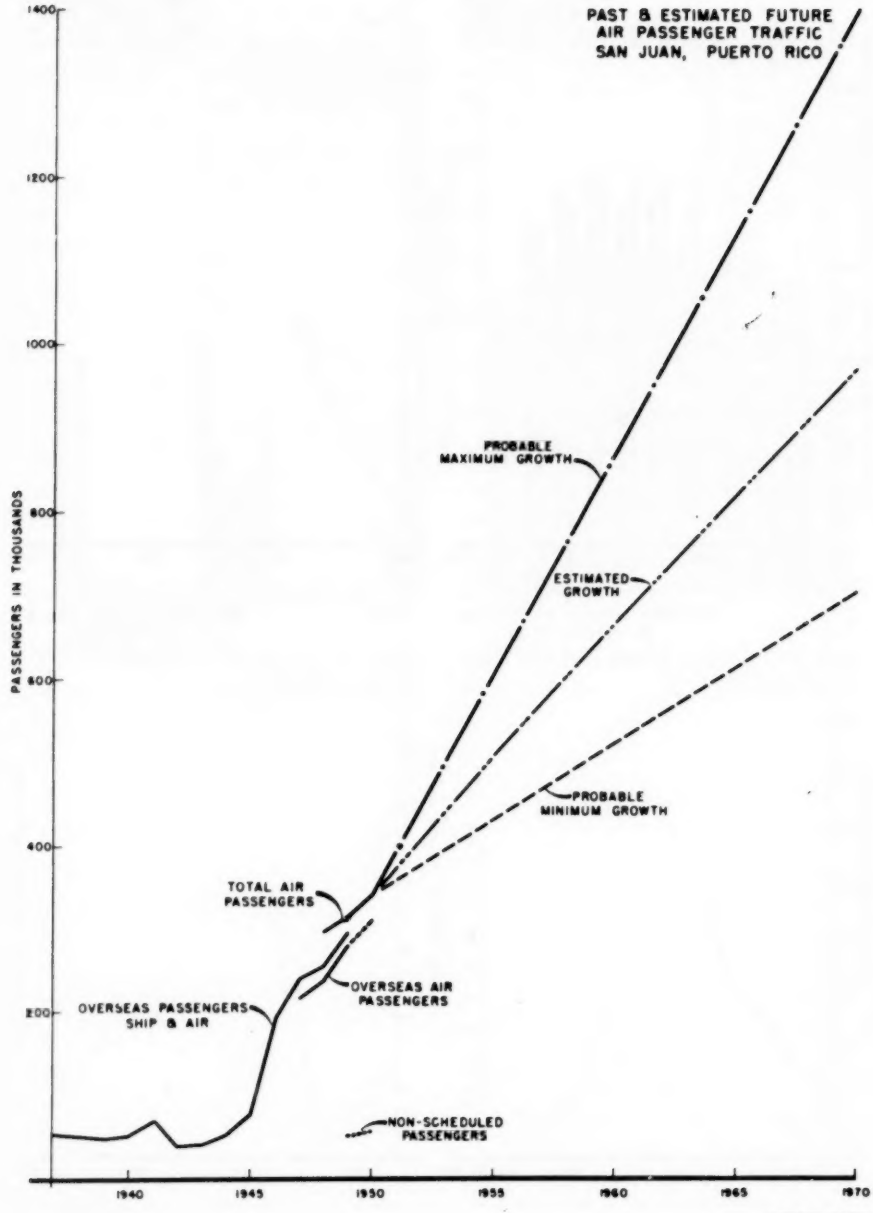

FIG. 2

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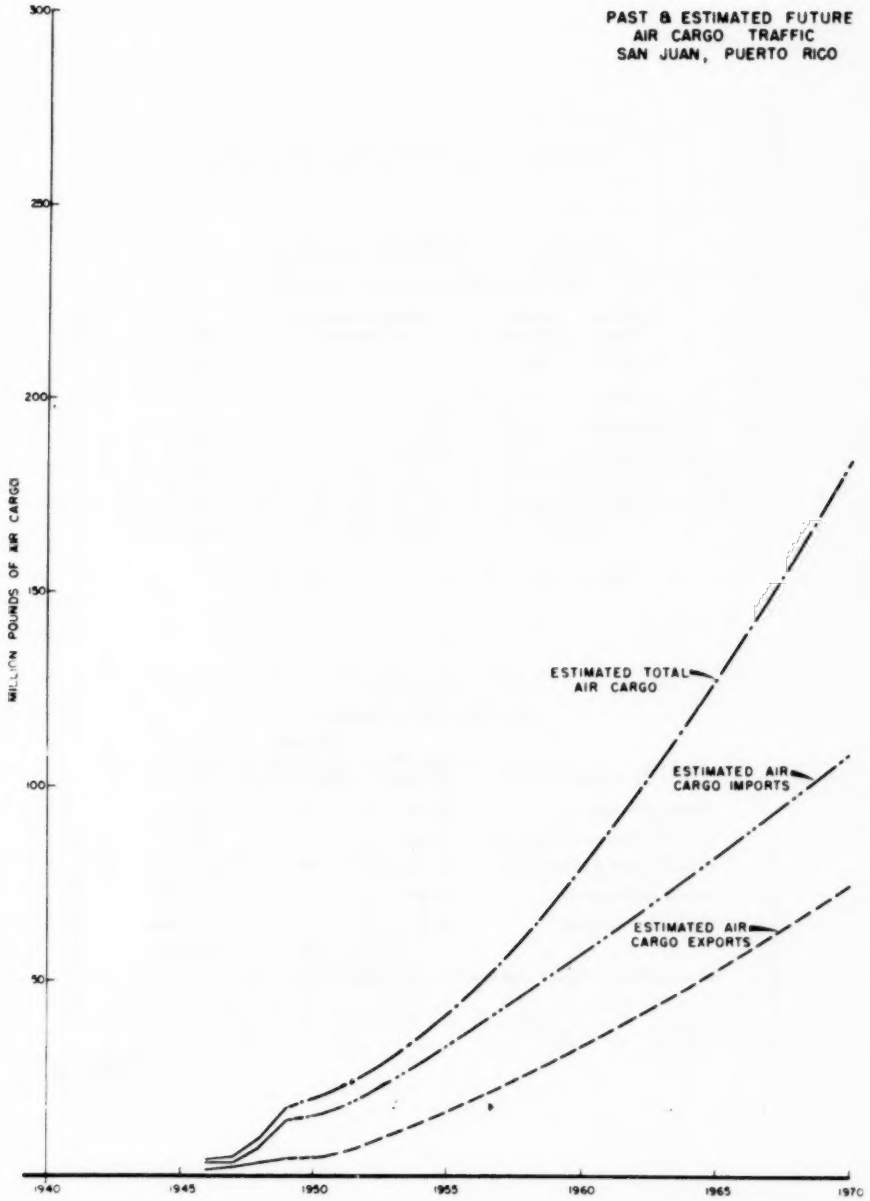
PUERTO RICO INTERNATIONAL AIRPORT
PUERTO RICO TRANSPORTATION AUTHORITY



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PUERTO RICO INTERNATIONAL AIRPORT
PUERTO RICO TRANSPORTATION AUTHORITY

FIG. 3

TABLE III

Estimated Airplane Capacity - Passenger

Airplane Type	Seating Capacity		Relative Frequency of Operation		Total
DC-4	60	x	3	=	180
DC-6	60	x	2	=	120
Constellation	50	x	2	=	100
C-240	40	x	5	=	200
B-377	70	x	1	=	70
C-46	60	x	1	=	60
			14		730

Average size is 730 ÷ 14 = 52 x 55% load factor = 29

TABLE V

Gate Utilization - Passenger

Operation	Elapsed Time At Gate		Relative Frequency of Occurrence	Total Time
Arrival (All Types)	20 min.	x	43	860
Departure (Local or Virgin Is.)	20 min.	x	10	200
Departure (Foreign or U.S.)	40 min.	x	33	1,320
Arrival (In-Transit)	30 min.	x	7	210 min.
Departure (In-Transit)	30 min.	x	7	210 min.
			100	2,800 min.

Average Time = 28 min. per operation or 2 operations per hour.

FIG. 4

1. PASSENGER TERMINAL BUILDING

A. Airlines		Present Sq. ft.	Pers.	1960 Sq. ft.	Pers.	1970 Sq. ft.	Pers.
Air France	**	–	–	–	–	–	–
B.W.I.A.		504	3	1,500	10	2,250	15
Caribair		1,607	24	6,400	50	8,000	65
Chicago & Southern	**	–	–	–	–	–	–
Eastern		1,591	10	4,500	25	6,000	40
Iberia	**	–	–	–	–	–	–
Pan-American		8,235*	94	16,000	150	24,000	200
Non-Scheduled		4,200	–	5,000	–	5,000	–
Aeronautical Radio, Inc.		800	NA	2,000	15	2,500	20
TOTAL		16,937	131	35,400	250	47,750	340
B. Government Agencies							
P.R. Dept. of Agriculture		2,291	10	4,500	20	5,500	25
P.R. Dept. of Labor		400	2	1,500	4	2,000	6
U.S. Dept. of Agriculture		764	15	3,000	30	4,000	40
U.S. Dept. of Public Health		2,206	7	4,400	15	6,000	20
U.S. Dept. of Immigration		5,240	7	6,400	15	8,000	20
U.S. Dept. of Customs		4,500	33	9,000	50	11,000	65
U.S. Post Office		–	–	3,000	30	4,000	40
Weather Bureau Briefing Rm.		–	–		2		5
TOTAL		13,401	74	31,800	166	40,500	219
C. Public Space							
Waiting Rooms		23,300	–	40,000	–	55,000	–
Observation Decks		3,680	–	7,500	4	10,000	6
Nursery		–	–	1,500	2	2,000	3
Toilets		1,660	–	3,000	2	4,000	3
Stairs & Corridors		8,093	–	8,000	–	11,000	–
Information Booth		100	–	200	–	300	
TOTAL		36,833		60,200	8	82,300	12
D. Services							
PRTA Administrative Office		496	6	1,000	12	1,500	18
PRTA Operations Office		700	80	2,000	160	3,000	240
Porters' Lockers & Toilets		511	–	1,000	50	1,500	75
Toilets		1,052	–	2,000	–	3,000	–
Mechanical Eq'p't. Rooms		687	–	2,000	–	3,000	–
TOTAL		3,246	86	8,000	222	12,000	333

*Does not include Commissary
**Operations handled by other carrier

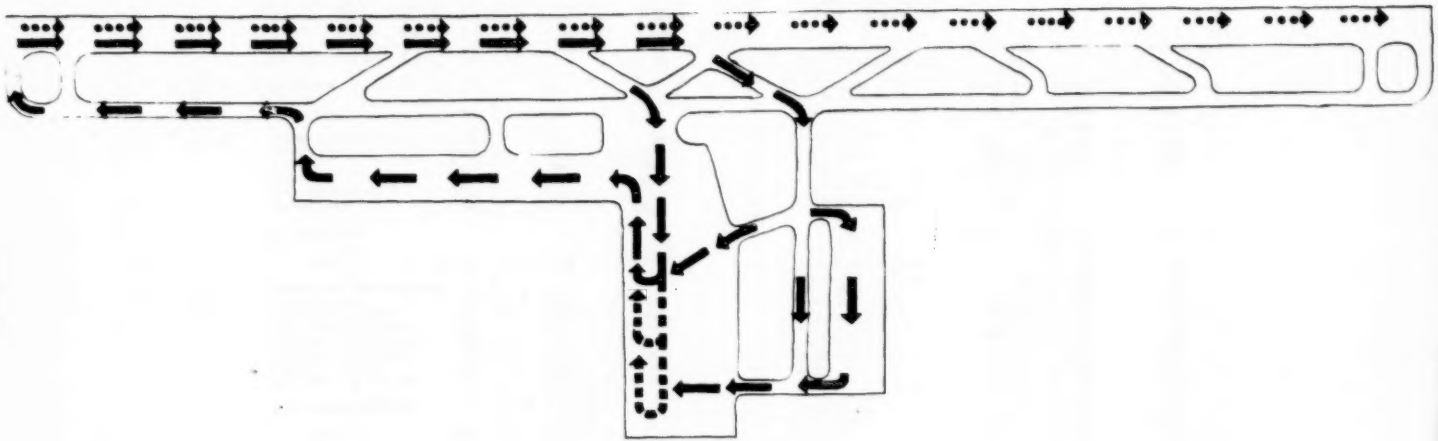
1. PASSENGER TERMINAL BUILDING (cont'd)

E. Concession & Rental Areas		Present Sq. ft.	Pers.	1960 Sq. ft.	Pers.	1970 Sq. ft.	Pers.
Offices (Texaco, Bird's, etc.)		1,264	6	2,500	12	3,000	15
Casino		–	–	1,500	10	1,500	10
Restaurant	*	3,325	12	5,000	20	7,500	30
Coffee Shop	*	3,050	5	5,000	10	7,500	15
Cafeteria	*	3,525	12	5,000	20	7,500	30
Snack Bar		300	2	600	4	600	4
Liquor Bar	*	1,250	2	1,500	3	1,500	3
Barber Shop		400	2	600	3	600	3
Drug Store		400	2	1,000	4	1,000	4
Florist		–	–	400	2	400	2
Gift Shop		1,612	3	2,000	4	2,000	5
News Stands		704	2	1,500	4	2,000	5
Cable Counter		100	1	200	2	200	2
Roomettes (30)		–	–	4,500	5	4,500	5
Conference Rooms (2)		–	–	600	1	600	1
Bank		–	–	1,000	5	1,000	5
Haberdashery		–	–	1,000	2	1,000	2
Guided Tours		–	–	200	1	200	1
Visitor's Bureau		200	1	200	1	200	1
Auto Rental Counter		–	–	100	1	100	1
Telephones (No)		(6)	–	(12)	–	(18)	–
Parcel Lockers (No)		–	–	(100)	–	(150)	–
Insurance Machines (No)		–	–	(10)	–	(15)	–
Vending Machines (No)		–	–	(40)	–	(60)	–
TOTAL		16,130	98	34,400	114	42,900	163
F. Government Offices							
C.A.A.		5,989	62	10,300	70	10,500	75
Control Tower		750	–	1,000	5	1,250	7
Weather Bureau		1,758	6	2,700	10	2,700	10
Other Offices			–	2,000	7	5,000	10
Circulation, Toilets, etc.		1,463	–	2,000	–	2,500	–
TOTAL		9,960	68	18,000	92	19,750	102
TOTAL FOR PASSENGER TERMINAL		96,507	429	187,800	852	245,200	1,149
2. AUTO PARKING FOR PASSENGER TERMINAL BUILDING		310		780		1,030	

*Includes proportional kitchen and utility space

FIG. 5

PUERTO RICO INTERNATIONAL AIRPORT



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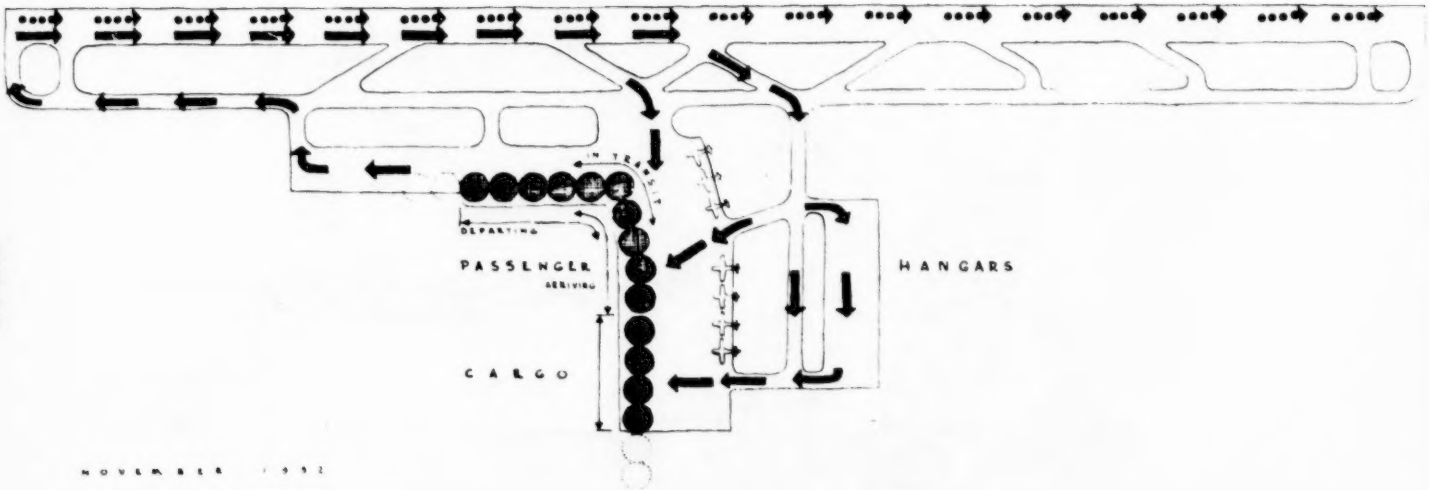
NOVEMBER 1963

PREPARED BY PRATTS ABBETT ENGINEERING CO
ARCHITECTS AND ENGINEERS
TORO FERRER & TORREGROSA
CONSULTING ARCHITECTS

BASIC AIRPLANE TAXI PATTERN

(FIG. 6)

PUERTO RICO INTERNATIONAL AIRPORT



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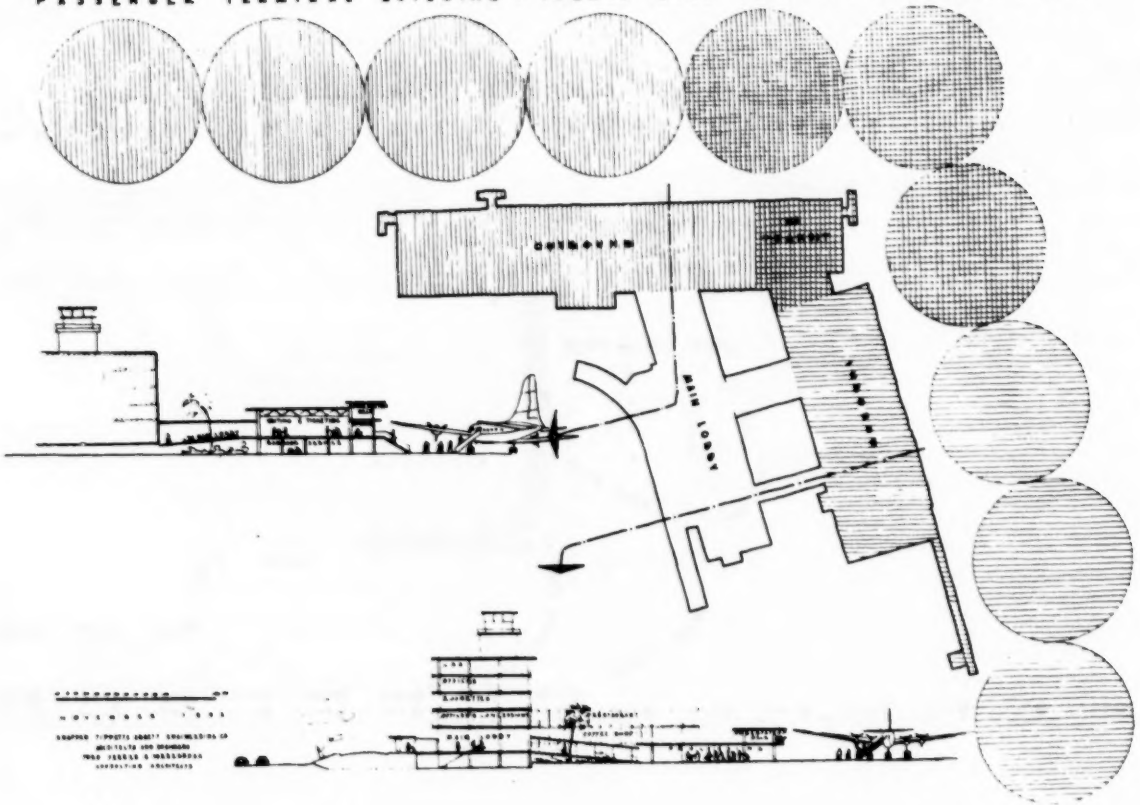
NOVEMBER 1952

CHAPPELL TIPPETTS ABBETT ENGINEERING CO
ARCHITECTS AND ENGINEERS
YORO TERRES & TORREGROSA
CONSULTING ARCHITECTS

IMMEDIATE & FUTURE AIRPLANE PARKING POSITIONS

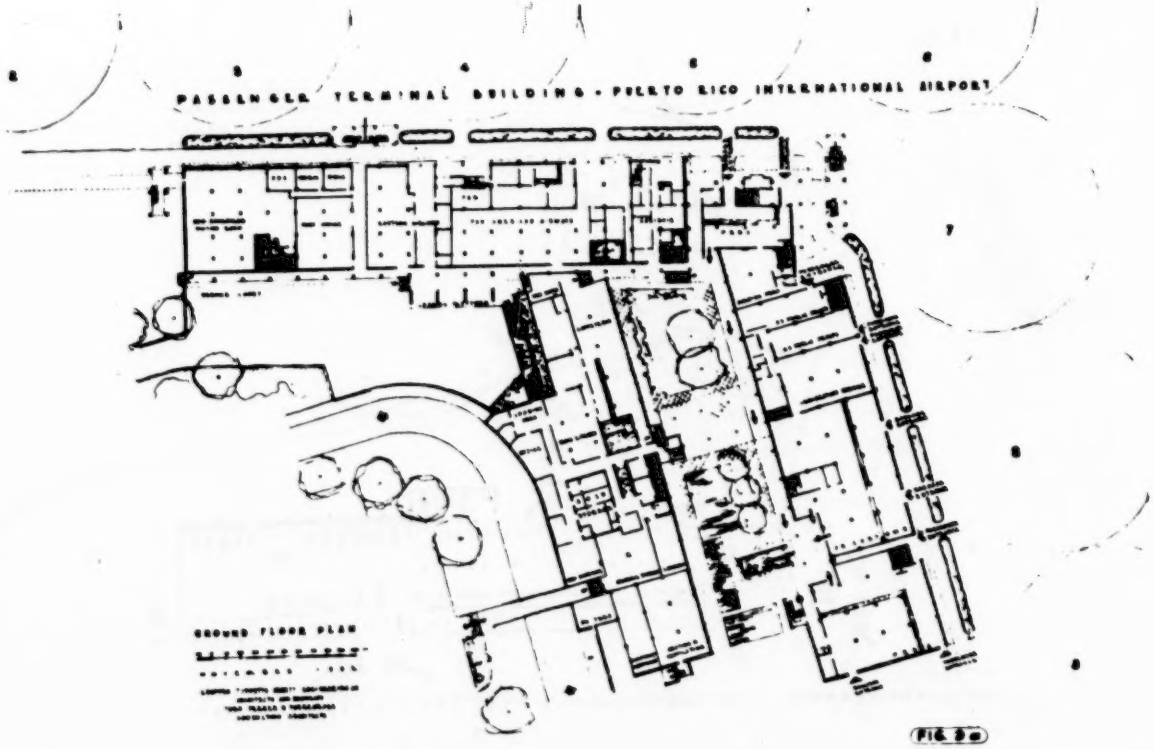
FIG. 7

PASSENGER TERMINAL BUILDING • PUERTO RICO INTERNATIONAL AIRPORT

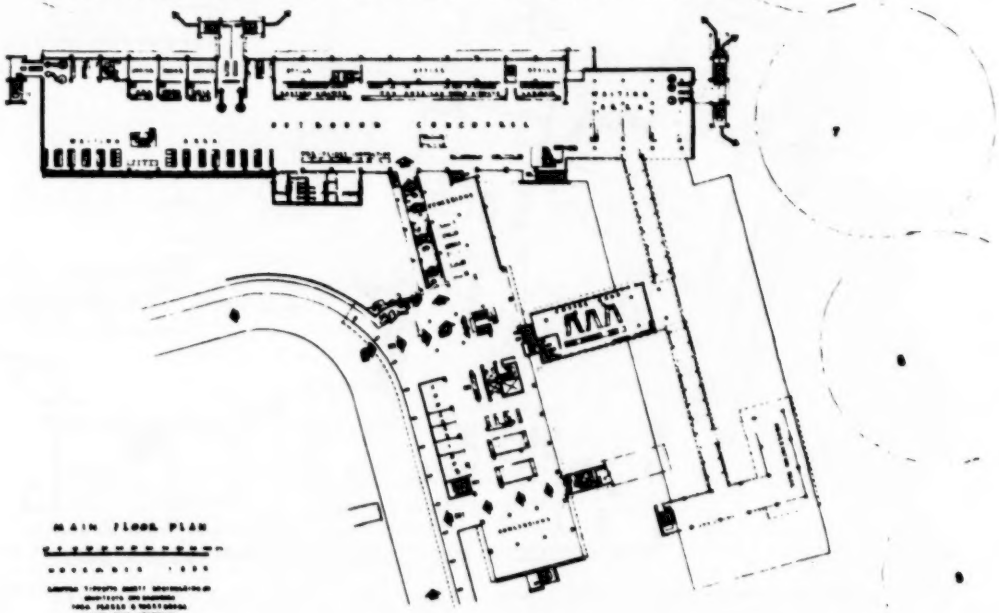


RELATIONSHIP OF AIRPLANE PARKING POSITIONS TO MAJOR SPACES

FIG. 8


PASSENGER TERMINAL BUILDING - PUERTO RICO INTERNATIONAL AIRPORT
GROUND FLOOR PLAN
FIG. 3a

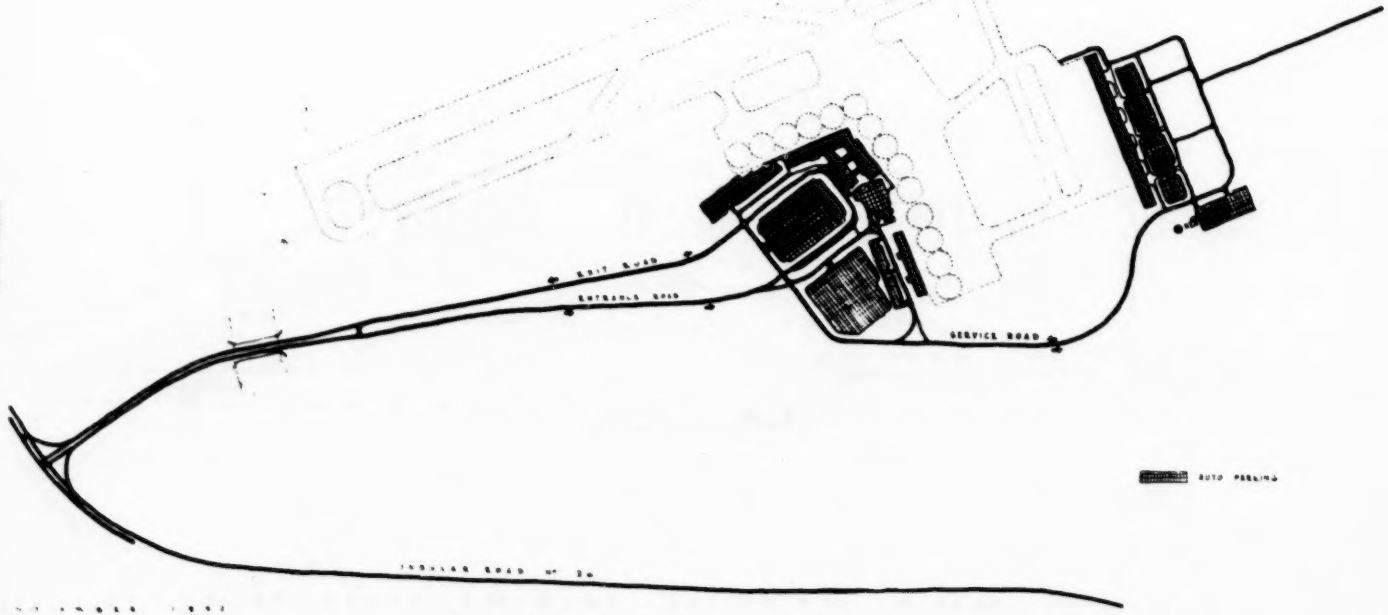
PASSENGER TERMINAL BUILDING - PUERTO RICO INTERNATIONAL AIRPORT



MAIN FLOOR PLAN

(FIG. 96)

PUERTO RICO INTERNATIONAL AIRPORT



ROADWAY LAYOUT

(FIG. 10)

CARGO TERMINAL BUILDING • PUERTO RICO INTERNATIONAL AIRPORT

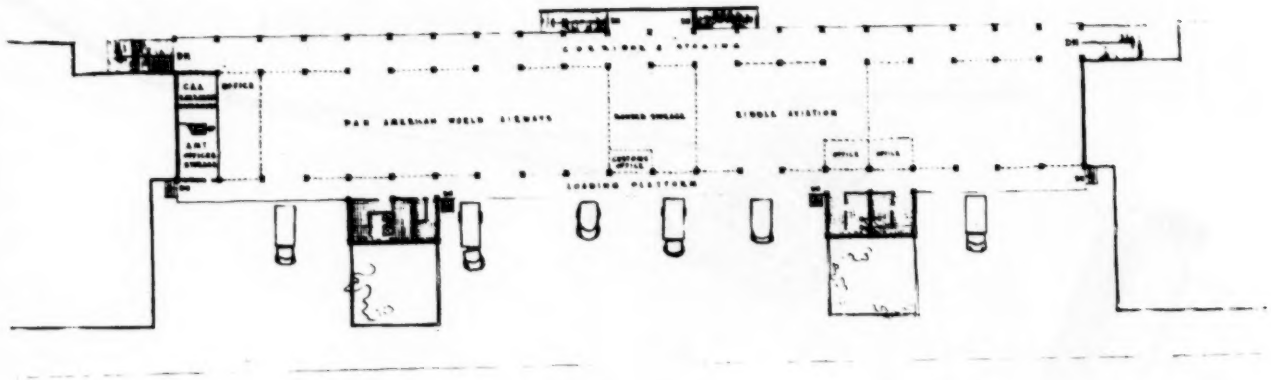


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FIG. 11

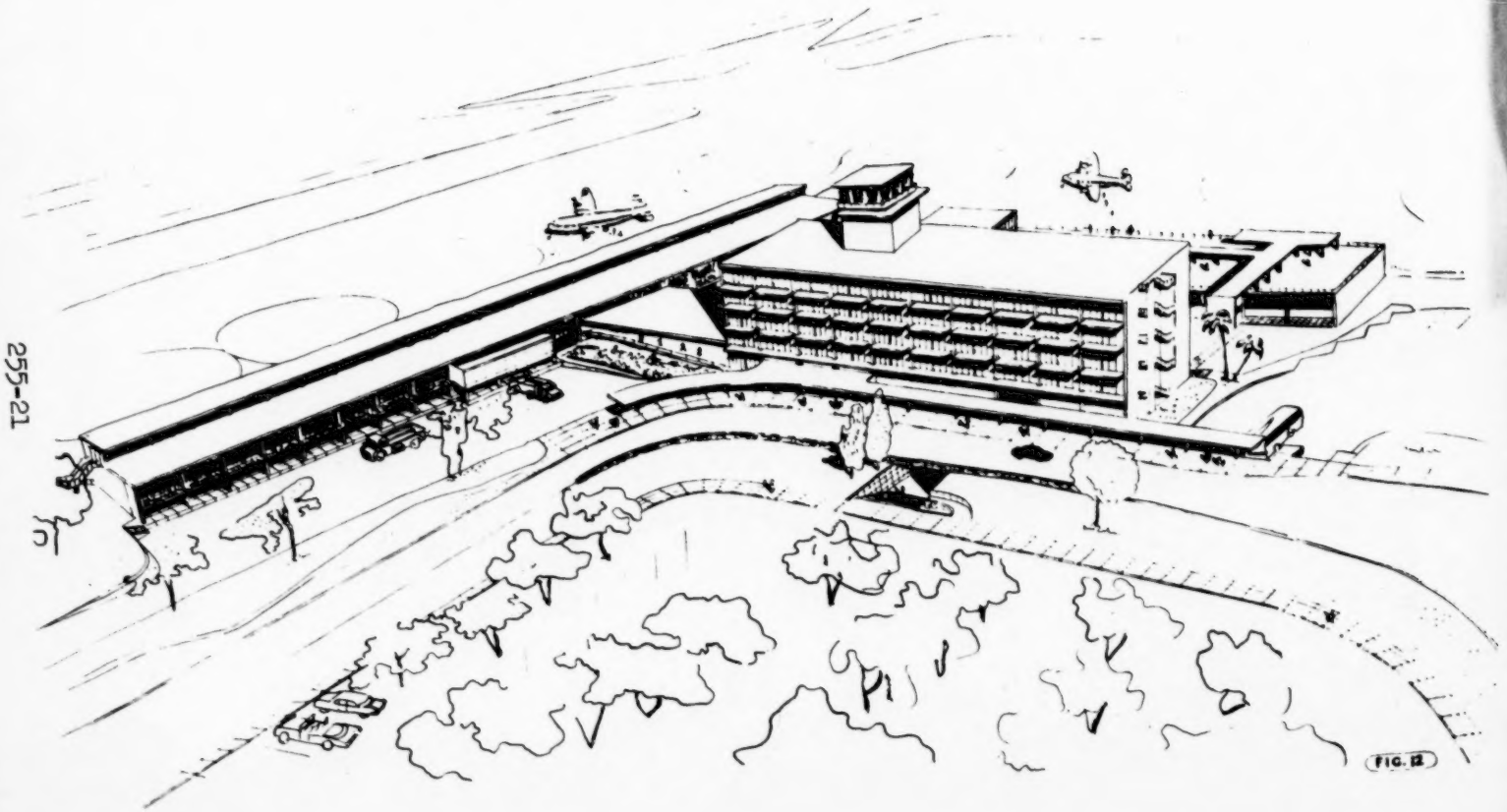

FIG. 12

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